2016

Sunflower Planting Date x Variety Trial

Heather Darby
University of Vermont, heather.darby@uvm.edu

Sara Ziegler
University of Vermont

Nate Brigham
University of Vermont

Julija Cubins
University of Vermont

Abha Gupta
University of Vermont

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Dr. Heather Darby, UVM Extension Agronomist
Sara Ziegler, Nate Brigham, Julija Cubins, and Abha Gupta
UVM Extension Crops and Soils Technicians
(802) 524-6501

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2016 SUNFLOWER PLANTING DATE x VARIETY TRIAL

Dr. Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

Sunflowers are being grown in the Northeast for their potential to add value to a diversified operation as fuel, feed, fertilizer, and an important rotational crop. However, pest pressures from seed-boring insects, disease, and birds can limit yield and quality, making the crop less viable for existing and potential growers. Addressing some of these pest pressures with agronomic management strategies may help mitigate yield losses. One cultural pest control strategy is manipulation of planting date. To evaluate the impacts of altered planting dates on sunflower pests and yields across varieties, an on-farm trial was designed and implemented by the University of Vermont Extension's Northwest Crops & Soils Program in 2016.

MATERIALS AND METHODS

To assess the effect of varying planting dates on sunflower pest pressures, yield, and quality, a field trial was initiated at Borderview Research Farm in Alburgh, VT in 2016 (Table 1). The experimental design was a randomized complete block with split plots and four replications. The main plots were three planting dates, each spaced approximately one week apart (24-May, 1-Jun, and 9-Jun). The subplots were six varieties whose agronomic information is listed in Table 2.

Table 1. Agronomic field management, Alburgh, VT, 2016.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Corn silage with rye cover crop
Replications	4
Plot size (ft.)	5 x 20
Planting equipment	John Deere 1750 MaxEmerge planter
Sunflower seeding rate (seeds ac^{-1})	34,000 seeds per acre
Row width (in.)	30
Weed control	1.5 pints ac^{-1} Trust® 17-May; 12 oz ac^{-1} Select Max® 10-Jun
Planting dates	24-May, 1-Jun, and 9-Jun
Starter fertilizer (at planting)	10-20-20 250 lbs ac^{-1}
Harvest dates	12-Oct

The soil type at the site was a Benson rocky silt loam and the previous crop was corn with a rye cover crop. The seedbed was prepared according to standard local practices, with chisel plow, disc, and spike tooth harrow. Sunflowers were planted in 30" rows with a John Deere 1750 corn planter fitted with sunflower finger pickups. Each 5'x 20' plot was planted at 34,000 seeds ac^{-1}, and 250 lbs ac^{-1} of a 10-20-20 of starter fertilizer was applied at planting. Trust® (trifluralin) was applied at 1.5 pints ac^{-1}on 17-May. Plots were sprayed with 12 oz ac^{-1} Select Max® (clethodim) on 10-Jun.

Table 2. Variety information for six sunflower varieties, 2016.

Variety	Maturity	Market	Traits
Camaro II	Medium	NuSun®	Clearfield®, DMR
Cobalt II	Early	High oleic	Clearfield®, DMR
Duet	Medium	NuSun®	Clearfield®, DMR
Falcon	Medium	NuSun®/bird seed	Express Sun®
N5LM307	Med-Early	Conoil	Clearfield®, DMR
N4HM354	Med-Early	High oleic	Clearfield®, DMR

Clearfield® = tolerant of Beyond® ammonium salt of imazamox herbicide;
ExpressSun® = tolerant of Express® tribenuron methyl herbicide; NuSun® = 55-75% oleic acid;
DMR = Downy Mildew Resistant.

Populations were counted in each plot on 7-Jul. Due to late timing of counting populations, sunflowers were not thinned. Dates when at least 75% of the plot was in full bloom were recorded on an ongoing basis. Plant stand characteristics such as bird damage, disease incidence, and lodging were measured just prior to harvest. Disease incidence was recorded simply as absence or presence of disease on any part of any plant within the plot. Issues with white mold (*Sclerotinia sclerotiorum*), a fungus which can overwinter in the ground and spread quickly in wet seasons, has proven problematic in the Northeast in the past. Assessing 10 random plants in each plot and estimating the percentage of each head that was missing seed measured the amount of bird damage. Lodging was visually estimated on a per plot basis by estimating the percentage of the plants in the plot that had lodged. All plots were harvested with an Almaco SPC50 plot combine with a 5' head and specialized sunflower pans made to efficiently collect sunflower heads. At harvest, test weight and seed moisture were determined for each plot with a Berckes Test Weight Scale and a Dickey-john M20P moisture meter. Subsamples were assessed for seed damage from boring insects by counting the number of seeds out of 100 randomly selected seeds from each plot that had an insect exit hole present. Oil from a known volume of each seed sample was extruded on 28-Feb and 1-Mar 2017 with an AgOil M70 Press, and the oil quantity was measured to calculate oil content. Oil yield (in lbs ac^{-1} and gallons ac^{-1}) was adjusted to 7.5% pressing moisture and reported.

Data were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within the trial were treated as random effects and treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two treatments. In the following example, hybrid C is significantly different from hybrid A but not from hybrid B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these hybrids did

Treatment	Yield
A	6.0
B	7.5*
C	**9.0***
LSD	2.0

not differ in yield. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0. This means that the yields of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

RESULTS

Weather data was collected with an onsite Davis Instruments Vantage Pro2 weather station equipped with a WeatherLink data logger. Temperature, precipitation, and accumulation of Growing Degree Days (GDDs) are consolidated for the 2016 growing season (Table 3). Historical weather data are from 1981-2010 at cooperative observation stations in Burlington, VT, approximately 45 miles from Alburgh, VT.

In general, the summer of 2016 was drier than normal, with all months except October having below normal precipitation. Temperatures were slightly above average August-October. From June through October there were an accumulated 3179 GDDs for sunflower (calculated at a base temperature of 44°F), 231 more than the long term average.

Table 3. Consolidated weather data and GDDs for sunflowers 2016, Alburgh, VT.

Alburgh, VT	June	July	August	September	October
Average temperature (°F)	65.8	70.7	71.6	63.4	50.0
Departure from normal	0.0	0.1	2.9	2.9	1.9
Precipitation (inches)	2.8	1.8	3.0	2.5	5.0
Departure from normal	-0.88	-2.37	-0.93	-1.17	1.39
Growing Degree Days (base 44°F)	655	826	849	595	254
Departure from normal	1	1	82	98	49

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages Are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Planting date x variety interactions

There was a statistically significant interaction between planting date and variety for test weight, bird damage, and insect damage. These interactions indicate that the varieties responded differently in terms of these parameters when planting was delayed to later dates.

Some varieties produced the highest test weights when planted earlier while some varieties produced the highest test weights when planted later (Figure 1). For example, Falcon produced seed that had a test weight almost three lbs bu^{-1} higher when planted on the first planting date compared to the second or third. However, Camaro II produced seed that was three lbs bu^{-1} lower on the first planting date compared to the third planting date. In addition, Cobalt II did not vary in test weight across planting dates. Falcon and Duet are listed a medium maturing varieties and may have benefited from the extended growing season allowed with an earlier planting date. Although we observed these variations across varieties and planting dates, no treatment produced seed under the standard sunflower test weight of 28 lbs bu^{-1}.

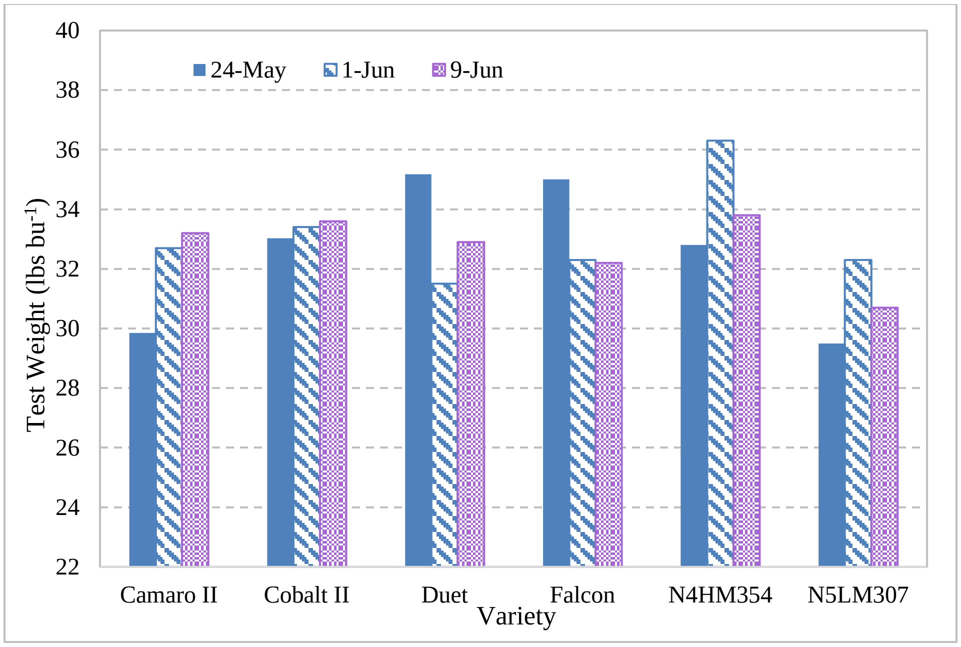

Figure 1. Planting date by variety interaction for test weight, 2016.

Some varieties exhibited drastic differences in insect damage across the three planting dates while others varied very little (Figure 2). For example, Camaro II had 4.0% damage when planted on the first planting date but only 0.25% when planted on the third planting date. However, Duet had 0.5% damage on the first planting date and 1.0% damage on the third planting date. Again this may be related to plant maturity ranges differing across the varieties.

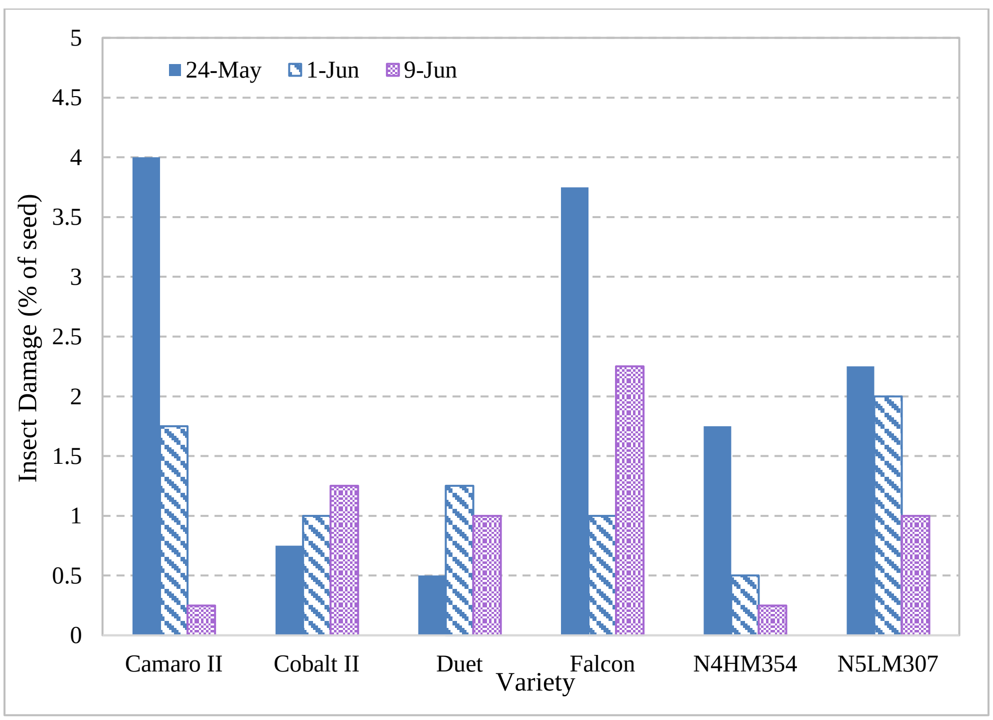

Figure 2. Planting date by variety interaction for insect damage, 2016.

Similarly, varieties did not respond similarly, in terms of bird damage to the heads, to delayed planting. Most varieties saw the largest bird damage in the first planting date, upwards of 60%, and the smallest on the third planting date (Figure 3). However, the variety N5LM307 hardly varied across planting dates with about 15.0% damage occurring regardless of planting date. This may indicate that this variety has a head position or architecture that protects the seeds from being eaten by the birds.

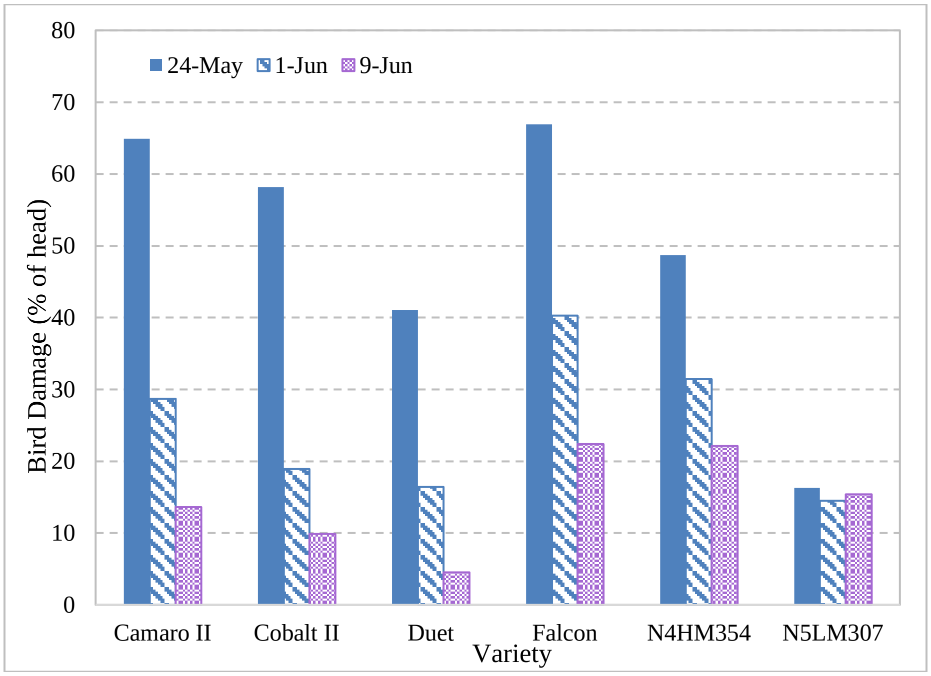

Figure 3. Planting date by variety interaction for bird damage, 2016.

Impacts of planting date

Plant characteristics, including bird damage and lodging, varied significantly across planting dates (Table 4). Bird damage ranged from 14.7% to 49.5% with a trial average of 29.7%. There were lower levels of bird damage observed in later planting dates. Lodging ranged from 10.3% to 24.2% with an average of 16.8% for the trial. The third planting date also had the lowest lodging but was statistically similar to the first planting date. Sclerotinia was present in the trial, however it was not surveyed for severity, only presence in each plot. On average, 22.2% of plots in each planting date had some Sclerotinia present.

Table 4. Plant stand characteristics by planting date, 2016.

Planting date	Bird damage %	Sclerotinia presence % plots	Lodging %
24-May	49.5	20.8	15.8*
1-Jun	25.0	25.0	24.2
9-Jun	**14.7***	**20.8**	**10.3***
LSD (0.10)	6.43	NS	11.6
Trial mean	29.7	22.2	16.8

Treatments with an asterisk* performed similarly to the top performer in **bold.**
NS-No significant differences.

Seed moisture at harvest, insect damage, and seed yield, also varied significantly by planting date (Table 5). Seed moistures at harvest ranged from 7.82% to 10.3% with an average of 8.77% across the whole trial. The lowest moistures were observed in the first and second planting dates which performed statistically similarly in terms of harvest moisture. Insect damage, measured as the percentage of seed that was damaged by seed-boring insects (Image 1), ranged from 1.00% to 2.17% with a trial average of 1.47%. The third planting date showed the lowest insect damage although statistically similar to the second planting date. In addition, overall insect damage levels were low which is also reflected in the test weights. Test weight ranged from 32.6 to 33.1 lbs bu^{-1}, which was not statistically different by planting date. All test weights were above the standard sunflower test weight of 28 lbs bu^{-1}. Yields differed statistically across planting dates ranging from 879 lbs ac^{-1} for the first planting date and 2196 lbs bu^{-1} for the third planting date.

Table 5. Seed characteristics by planting date, 2016.

Planting date	Seed moisture %	Test weight lbs bu^{-1}	Insect damage %	Seed yield lbs ac^{-1}
24-May	**7.82**	32.6	2.17	879
1-Jun	8.15*	**33.1**	1.25*	1015
9-Jun	10.3	32.7	**1.00**	**2196**
LSD (0.10)	1.39	NS	0.661	409
Trial Mean	8.77	32.8	1.47	1363

Treatments with an asterisk* performed similarly to the top performer in **bold.**
NS-No significant differences.

Image 1. Insect damage
Photo credit: sunflowernsa.com

When seed yields and bird damage are compared across planting dates (Figure 4), it is clear that as planting dates are delayed, bird damage decreases and seed yields increase.

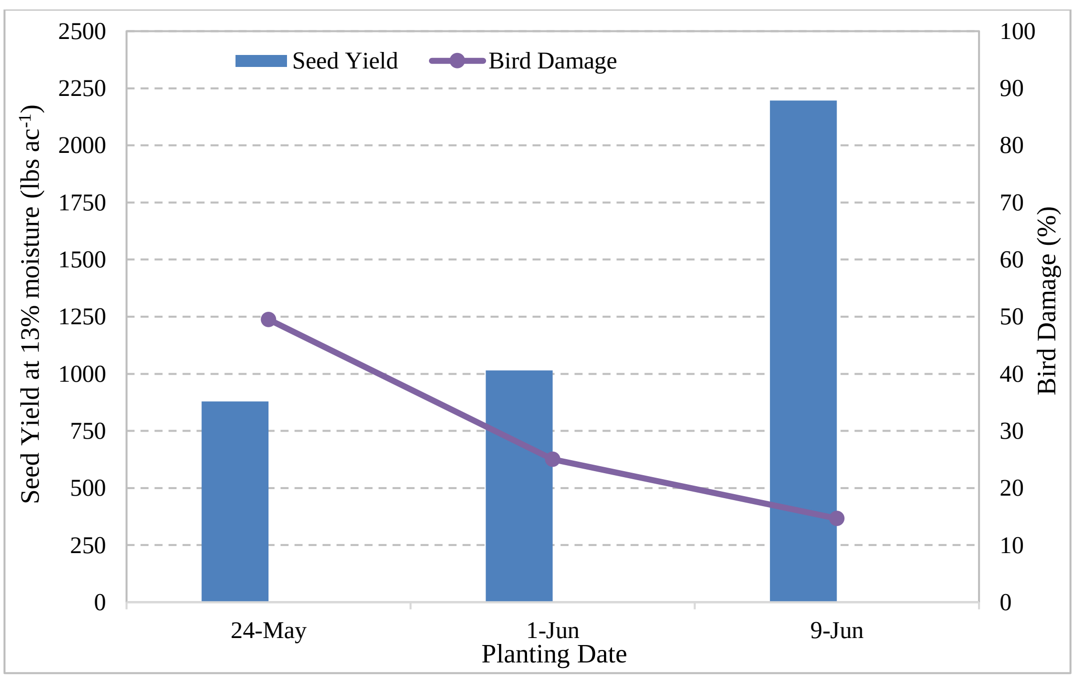

Figure 4. Sunflower seed yield and bird damage across three planting dates, 2016.

Oil content and yield also differed significantly by planting date (Table 6). Oil content ranged from 35.1 to 38.2% and increased with later planting dates, however the second and third planting date were statistically similar. Oil yields ranged from 304 to 819 lbs ac^{-1} and were the highest at the latest planting date. The third planting date yielded 819 lbs ac^{-1}, which equates to 107 gal ac^{-1}, more than twice that of the other two planting dates. Oil content was exceptionally high compared to what we typically see in our trials, for instance, in 2015 oil content averaged only 23.1%.

Table 6. Oil content and yield by planting date, 2016.

Planting date	Oil content %	Oil yield lbs ac^{-1}	gal ac^{-1}
24-May	35.1	304	40
1-Jun	37.9*	364	48
9-Jun	**38.2***	**819***	**107***
LSD (0.10)	1.65	156	20.5
Trial Mean	37.1	495	65

Treatments with an asterisk* performed similarly to the top performer in **bold.**

Image 2. AgOil M70 press.

Impacts of Variety

Plant stand characteristics, including bird damage and Sclerotinia presence, statistically varied by variety (Table 7, Figure 5). Bird damage ranged from 15.4% to 43.2% with a trial average of 29.7%. The lowest bird damage was observed in the variety N5LM307 which was statistically similar to Duet. The variety N5LM307 was the only conoil variety in the trial which may have influenced its lack of appeal to the birds compared to some of the other high-oil and bird seed market sunflower varieties. Conoil varieties are typically utilized by dehulling for kernel use in the baking industry. The highest bird damage was observed in the variety Falcon.

Sclerotinia presence ranged from 0.00 to 50.0% presence with an average of 22.2% for the trial. The lowest disease presence was observed in Duet, which was statistically similar to Falcon, Camaro II, and N5LM307. The highest incidence of disease was noted in Cobalt II where 50.0% of plots had Sclerotinia present. It is important to note that the figures here only reflect the percent of plots within each variety in which at least one Sclerotinia infected sunflower plant was observed; it does not indicate the severity or potential differences in infection severity between varieties. Lodging ranged from 10.0 to 20.8% but did not differ significantly by variety.

Table 7. Stand characteristics by variety, 2016.

Variety	Bird damage %	Sclerotinia presence % plots	Lodging % plants
Camaro II	35.7	16.7*	**10.0**
Cobalt II	29.0	50.0	20.0
Duet	21.0*	**0.00***	16.3
Falcon	43.2	8.33*	14.6
N5LM307	**15.4***	25.0*	18.8
N4HM354	34.1	33.3	20.8
LSD (0.10)	9.10	28.1	NS
Trial mean	29.7	22.2	16.8

Treatments with an asterisk* performed similarly to the top performer in **bold**.
NS-No significant difference.

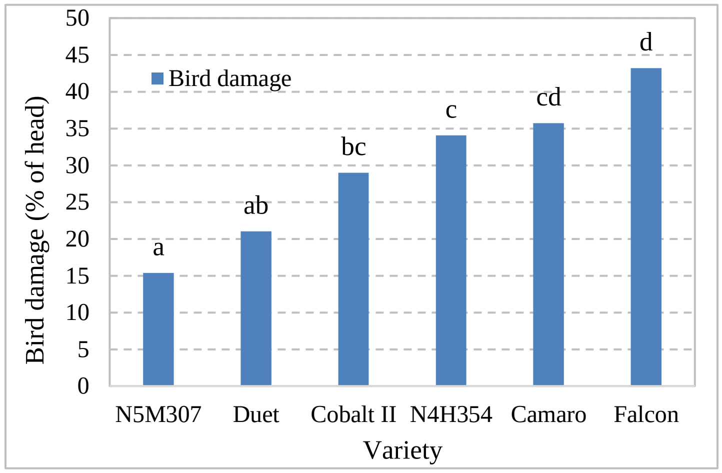

Figure 5. Bird damage by variety, 2016.

Seed characteristics, including test weight, insect damage, and seed yield, also varied significantly by variety (Table 8). Test weights ranged from 30.8 to 34.3 with an average of 32.8 lbs bu^{-1}, the highest observed in our trials to date. All varieties produced full seed that exceeded the standard sunflower test weight of 28 lbs bu^{-1}. Insect damage also varied significantly by variety. The lowest levels of damage were seen in the variety N4HM354, which was statistically similar to all other varieties except Camaro II and N5LM307. However, the highest level observed was still only 2.50% indicating little insect pressure this year. This is also reflected in the above average test weights. Seed yield also varied dramatically by variety ranging from 1030 to 1923 with an average of 1363 lbs ac^{-1}. The highest yielding variety was Camaro II which performed statistically similarly to Duet. Seed moisture at harvest ranged from 7.99 to 9.35% but did not differ significantly by variety. All varieties produced seed that matured and dried to an adequate storage moisture.

Table 8. Seed characteristics by variety, 2016.

Variety	Seed moisture %	Test weight lbs bu^{-1}	Insect damage %	Seed yield lbs ac^{-1}
Camaro II	9.01	31.9	2.50	**1923***
Cobalt II	8.18	33.3*	1.00*	1251
Duet	9.19	33.2*	0.917*	1528*
Falcon	9.35	33.2*	2.33	1030
N5LM307	8.88	30.8	1.75*	1163
N4HM354	**7.99**	**34.3***	**0.833***	1286
LSD (0.10)	NS	1.68	0.935	578
Trial Mean	8.77	32.8	1.47	1363

Treatments with an asterisk* performed similarly to the top performer in **bold**.
NS-No significant difference.

Oil content and yield also differed statistically by variety (Table 9, Figure 6). Oil content ranged from 35.3 to 38.9% with Duet and N4HM354 producing highest levels. Oil yields ranged from 399 to 678 lbs ac^{-1}. The highest yielding variety for oil was Camaro II which also performed similarly to Duet and N4HM354.

Camaro produced almost 90 gal ac^{-1} oil, 16 more gal ac^{-1} than the next highest yielding variety Duet.

Table 9. Oil content and yield by variety, 2016.

Variety	Oil content %	Oil yield lbs ac^{-1}	Oil yield gal ac^{-1}
Camaro II	35.7	**678***	**89***
Cobalt II	37.5*	451	59
Duet	**38.9***	559*	73*
Falcon	35.3	399	52
N5LM307	36.6	405	53
N4HM354	38.5*	481*	63*
LSD (0.10)	2.33	221	28.9
Trial mean	37.1	495	65

Treatments with an asterisk* performed similarly to the top performer in **bold**.

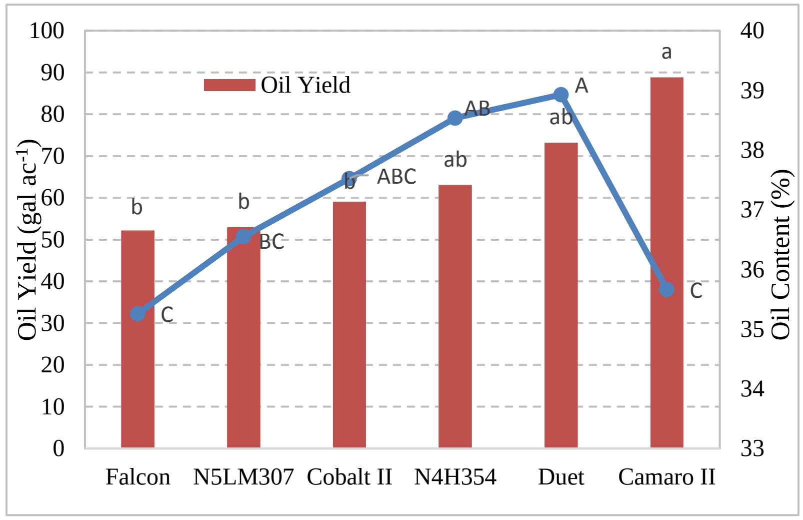

Figure 6. Oil yield and content by variety, 2016.

DISCUSSION

Overall, the sunflowers performed very well this year despite very droughty conditions throughout the entire season. Sunflowers are considered to be drought tolerant and this may have provided significant benefit to the crop this season. Yields and test weights remained high and reached some of the highest levels we have observed through our trials. Low insect and disease pressure may have contributed to these levels. The data collected this season support the hypothesis that delaying planting of sunflowers in this region until the second week in June can decrease losses due to birds and thus increase yields. However, we observed significant varietal interactions in this respect as not all varieties reacted similarly to the shift in planting date. The variety N5LM307 showed a constant level of bird damage of about 15% regardless of planting date while all other varieties showed very elevated levels of bird damage in earlier planting dates. Despite this however, N5LM307 had one of the lowest seed yields and oil contents leading to low oil yields. Although the variety Duet showed a statistically similar average bird damage to N5LM307, Duet exhibited a drastic difference between planting dates similar to the other varieties. These differences in response are important to investigate so that growers can understand how to best utilize the manipulation of planting date to avoid pest pressures and increase yields. However, it is important to remember that these data only represent one season and should not be used alone to make management decisions.

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